

Many of the environmental hazards begin in far more serious concentration as occupational hazards on the job.

Ralph Nader

testimony before the U.S. Senate Public Works Subcommittee, 17 May 1971

CHEMICAL EXPOSURES

# Origins of Obesity

Fifty-nine million Americans are considered obese, and 300,000 die each year from related causes, making this disorder the second-leading U.S. cause of death after smoking. The ever-expanding reach of obesity is leading some scientists to look beyond traditional explanations that implicate genes, diet, and physical activity. At a 20 February 2004 symposium titled *Obesity: Developmental Origins and Environmental Influences*, cosponsored by the NIEHS and the Duke University Integrated Toxicology Program, presenters discussed data that support the hypothesis that *in utero* or neonatal exposures to environmental chemicals, notably endocrine disruptors, play a role in the etiology of obesity.

It has long been known that estrogens regulate the size of adipocytes (fat cells) in adult humans and animals. The same phenomenon may occur in children, too. "Humans with childhood obesity as well as infants born to mothers with gestational diabetes have adipocyte hyperplasia, which predisposes them to adult obesity and the metabolic syndrome [characterized by metabolic risk factors such as excessive abdominal fat, blood fat disorders, and insulin resistance]," says Paul Cooke, a professor of reproductive biology at the University of Illinois at Urbana-Champaign. "Estrogens seem to influence the process of adipocyte hyperplasia as well as the consequences of adipocyte hyperplasia in terms of producing metabolic alterations and inducing obesity."

Retha Newbold, a developmental biologist with the NIEHS Environmental Toxicology Program, says there is compelling evidence that exposure to endocrine disruptors during critical phases of cell differentiation may have long-lasting consequences. "These exposures likely alter mechanisms involved in weight homeostasis," she says. "We're still trying to determine if it's a direct effect on the

adipose cells and how they differentiate or proliferate, or whether it's a disruption of the endocrine feedback loops."

Newbold's own research in this area has focused primarily on prenatal exposures to diethylstilbestrol (DES), a synthetic estrogen used in as many as 8 million pregnancies from the 1940s through the 1970s to prevent miscarriage. In animal studies, Newbold and others have shown that high-dose DES exposures during pregnancy produce small to normal-size offspring that tend to stay small as adults, whereas low-dose exposures produce normal-size offspring that tend to fatten as they age. This dose-dependent link with adult weight gain has been seen with prenatal exposure to other xenoestrogens and applies to neonatal exposure as well, says Newbold.



**From tiny to titanic.** Environmental exposures during fetal or neonatal development may set the stage for obesity later in life.

Dosage thresholds may be paramount, says Frederick vom Saal, a professor in the Division of Biological Sciences at the University of Missouri—even extremely low-level intrauterine exposure to the ubiquitous xenoestrogen bisphenol A, a constituent in food and beverage containers, can have far-reaching effects. "Low-dose exposure to bisphenol A increases differentiation of fat cells and also increases glucose transport, both of which may affect later development of obesity," he says. In research published in the August 1999 issue of *EHP Supplements*, vom Saal and colleagues found that a brief period of low-dose bisphenol A exposure during gestation in mice—an exposure resulting in blood levels much lower than those typically

found in pregnant women and their fetuses—resulted in an accelerated rate of postnatal growth for both male and female mouse pups, as well as early puberty in females. He emphasizes that the bisphenol A connection in humans is still only a hypothesis.

Obesity later in life also is associated with intrauterine exposure to other environmental exposures including cigarette smoke. "With nicotine exposure *in utero* we see generalized underresponsivity of the autonomic nervous system postnatally," says Edward Levin, an associate professor of environmental sciences and policy at Duke. Nicotine exposure could alter appetite-regulating neural systems in the brain as well as the peripheral noradrenergic system, which is involved in metabolic control over adipose tissue.

Nutritional stresses during gestation are other possible contributors to future obesity. There are strong positive correlations between gestational diabetes, birthweight, and adolescent obesity; the mechanism may involve transfer of maternal glucose to the fetus, thereby stimulating the production of fetal insulin, which acts as a fetal growth hormone. Given the known associations, it is reasonable to speculate that simultaneous exposure to environmental estrogens might compound the weight-enhancing effects of insulin resistance during

pregnancy, says Sheila Collins, who heads the Endocrine Biology Program at CIIT Centers for Health Research in Research Triangle Park, North Carolina.

"At this point, all of the data must be considered preliminary," says Jerrold Heindel, a scientific program administrator for the NIEHS and one of the conference organizers. "Most of the data are from animal models, and there is still the possibility that the phenomena observed in animals may not apply to humans. Nonetheless, some of the findings presented at the meeting were rather striking." The meeting presentations are available online at <http://www.niehs.nih.gov/multimedia/qt/dert/obesity/agenda.htm>.  
—M. Nathaniel Mead

## PESTICIDES

## Contentious Worker Testing

Washington State farmworkers who mix, load, or apply organophosphate or *N*-methyl carbamate pesticides must now receive cholinesterase blood tests as part of a controversial new state rule. The goal of the new rule, which took effect in February 2004, is to identify workers who are at increased risk for gradual cumulative overexposure and subsequent poisoning. But the rule faces heated opposition from scientists and agricultural interests over questions of cost and effectiveness, and raises questions of environmental justice as well.

About 400,000 pounds of organophosphate and *N*-methyl carbamate pesticides were sprayed on Washington apple orchards in 2001, according to the National Agricultural Statistics Service. These pesticides bind to acetylcholinesterase, an enzyme that modulates nerve signals. As acetylcholinesterase activity is inhibited, nerves continue to fire uncontrollably. In humans, this can produce symptoms such as fatigue, nausea, headache, and seizures. Long-term effects may include weakness or paralysis of the extremities and impairments in concentration, memory, language, and personality.

Each year, says Washington Department of Labor and Industries (L&I) occupational nurse consultant John Furman, the state Department of Health receives about a dozen reports of acute poisoning from cholinesterase-inhibiting insecticides among farmworkers, mostly from when a pesticide is splashed on a worker. The new monitoring does not target these kinds of illnesses or exposures; instead, it aims to prevent the poisonings that result from gradual exposure. Although many U.S. employers have adopted voluntary cholinesterase monitoring as a precaution to protect workers, California is the only other state with mandatory testing, which has been in effect since 1974.

The Washington rule requires that workers provide a baseline blood sample before they begin handling pesticides during the spraying season. Follow-up tests are required if workers handle the pesticides for a total of 50 hours in any period of 30 consecutive days. If a worker's cholinesterase level drops by 21–29%, an inspector will visit the workplace to determine the cause of the exposure and recommend how to prevent it in the future. Workers must temporarily stop handling pesticides if acetylcholinesterase tests show a drop of 30% or more or if plasma cholinesterase drops by 40% or more. These

action thresholds are lower than the amounts of cholinesterase inhibition that would likely cause symptoms, says Furman.

Workers may not handle the pesticides until the difference between their test result falls to within 20% of their baseline. But their pay and seniority are guaranteed by the rule for up to three months—a reasonable amount of time for workers to recover, says University of Washington pesticide and health expert Matthew Keifer.

To ensure test reliability and valid comparison between baseline and subsequent test results, all tests are being done initially through the Washington State Public Health Laboratory near Seattle. Eventually the state plans to certify commercial labs for the analyses, Furman says. An advisory panel of scientists and physicians will track the test results and report periodically to L&I.

For some farmworkers, the rule is a mixed blessing. Some are reluctant to be tested for fear of missing work, being fired, or other reprisal. The 1 December 2003 *Seattle Times* quotes one worker as saying, “[We] don’t have the liberty to think about health in the short term because there are long-term consequences for the family.” Workers can opt out of testing, but this decision must be discussed between workers and their health care providers, a requirement aimed at stopping employers from coercing workers to avoid testing, says lawyer Dan Ford, who represented the farmworkers whose legal action spurred the L&I rule making.

In March 2004, the state legislature passed a measure that reduces the financial burden on growers by reimbursing them for testing and medical provider costs. The source of funding will likely be the state's workers compensation funds, says L&I spokeswoman Elaine Fischer, which shifts more of the costs to employers in industries besides agriculture who pay into the state system. Further, based on their experience with voluntary cholinesterase testing, agricultural interests have consistently argued that the tests are unlikely to provide any new information and hence are not worth the cost, according to Mike Gempler, executive director of the Yakima-based Washington Growers League.

Environmental toxicologist Allan Felsot, of the Food and Environmental Quality Laboratory at Washington State University Tri-Cities, believes it's important to limit workers' exposure, but says monitoring is the wrong way to do it. “Why waste time monitoring?” he says. “We should be focusing on prevention by finding and replacing faulty equipment and providing more worker education.”

—Rebecca Renner

## Unions Sue for Cleaner Factory Air

Two labor unions have filed suit against the U.S. Department of Labor in hopes of forcing the agency to enact recommended standards for exposure to toxic metalworking fluids. These fluids, used to reduce friction and improve product quality in heavy manufacturing, can cause acute and chronic respiratory conditions ranging from asthma to permanent scarring of the lungs, as well as a number of cancers and skin problems. Over 1 million U.S. workers may be exposed to these chemicals. In 1998 the National Institute for Occupational Safety and Health recommended a new standard 10 times more rigid than the current standard, but the recommendation has not been acted upon, for reasons the agency has never explained.



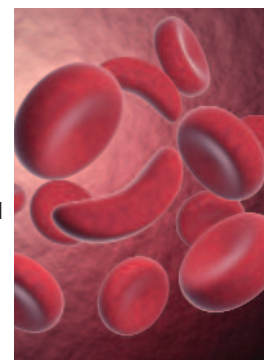
## Good Buy for Biocomplexity

As part of its continuing Biocomplexity in the Environment grant effort, the National Science Foundation in October 2003 announced awards totaling \$31.9 million for 30 science and engineering projects centered on better understanding biodiversity and the interrelationships among all living things. The grants will promote professional development, interdisciplinary research, and the development and use of novel technologies for observing natural processes of all kinds and helping to sustain extant species. Foundation director Rita Colwell said, “These investigations will provide a more complete understanding of natural processes and cycles, of human behaviors and decisions in the natural world, and of ways to use new technology effectively to observe the environment and sustain the diversity of life on Earth.”

## Smoking Out Sick Cell

Researchers from the University of California, Davis, have found that children with sickle cell disease who were exposed to environmental tobacco smoke (ETS) at home had more than

twice as many episodes of pain (known as “crises”) as sickle cell patients who were not exposed. Sickle cell crises involve vaso-occlusive pain, acute chest syndrome, and stroke, and often require hospitalization. In the study, crises were not influenced by other factors such as age or type of sickle cell disease. Reporting in the December 2003 issue of *Archives of Pediatrics and Adolescent Medicine*, the researchers estimate that ETS exposure increases the risk of crisis by 90% among children with sickle cell disease.





## EMFs

## Ozone Surprise

Once again, an accidental discovery may have aided science. Following up on a puzzling observation made years ago, analytical chemist Steven Goheen and his team at the Pacific Northwest National Laboratory write in the February 2004 issue of *Bioelectromagnetics* that high-voltage electrical devices can, under certain conditions, indirectly generate high ozone levels in the presence of an animal or water. Ozone is a respiratory irritant that can reduce lung function, aggravate asthma, and trigger asthma attacks.

In an earlier study linked to an investigation of why negatively charged ions kill bacteria, Goheen found that discharging a negative ion source into a flask containing a little water created ozone in the neighborhood of 1,500 parts per billion (ppb)—vastly higher than the U.S. Environmental Protection Agency 8-hour standard of 80 ppb. To

find out more about this quirk, Goheen and colleagues equipped an enclosed polycarbonate box with a stainless steel negative ion source—or corona discharge—in the roof, an exhaust tube in one side to monitor ozone, and a grounded wire mesh just above the floor. The corona discharge operated at a range of 5–10 kilovolts (kV), similar to that of certain high-voltage appliances such as negative ion generators. They either filled the bottom of the box with water or placed three rats in the dry box, then generated a corona discharge at 5, 7.5, or 10 kV, with the tip of the steel discharge rod kept at 1 or 8 centimeters (cm) from the rats' heads or the water.

With neither water nor rats in the box and the corona discharge on, ozone remained near its ambient level of about 15–20 ppb. With just water in the box, ozone rocketed to an average of 290 ppb. The increase was slightly less with the rats in the dry box, rising to about 255 ppb at 10 kV, with proportionately lower increases at lower voltages. The increases occurred

only at a distance of 1 cm, not at 8 cm. In addition to increased ozone production, the rats froze in place when the discharge was on, but moved freely when it was off, for unknown reasons.

The team speculates that moisture and the sharp points on fur and whiskers may be key factors that spur the production of ozone. Other variables Goheen suggests exploring include alternative voltages and distances, pulsed discharges, number and mass of animals, length of exposure, creation of chemical species other than ozone, and spatial volume.

The findings are intriguing, but the short distance from the rod to the animals suggests to some critics that the phenomenon is unimportant, because the tested scenarios are unlikely to reflect real-world situations. Much more study of this issue is necessary before it can rise to the level of a serious public health concern, says Robert Kavet, electromagnetic field business area manager at the electric utility-funded Electric Power Research Institute. —**Bob Weinhold**

## INDOOR AIR QUALITY

## HVAC Officemate

Heating, ventilation, and air-conditioning (HVAC) systems, particularly those in humid climates, frequently harbor microbial growth that may contribute to illness among workers. Researchers are on the lookout for technologies that can kill pathogens before they circulate throughout a work space. One such technology, ultraviolet germicidal irradiation (UVGI), has long been used to inactivate microbial aerosols, mostly in the occupied spaces of medical facilities. A study published in the 29 November 2003 *Lancet* suggests that UVGI lights installed in office HVAC systems can effectively reduce microbial growth and improve worker health.

Dick Menzies, director of the Respiratory Epidemiology Unit at Canada's McGill University, led a team of researchers in a double-blind trial of 771 participants working in three Montréal office buildings. UVGI lights were installed in the buildings' HVAC systems to irradiate cooling coils, drip pans, and filters. The lights were turned on for 4 consecutive weeks, then off for the next 12 weeks several times over one year. Office workers reported at several points throughout the year whether they had any of 10 specific symptoms, including headache, nasal congestion, and irritation of the skin, eyes, and nose.

During the test period, the researchers measured airborne microbes and endotoxins within the HVAC systems, in the outdoor air, and at selected workstations. Following exposure to UVGI, median concentrations of viable microorganisms and endotoxins on



**Working on cleaner air.** UV light can kill pathogens in HVAC systems, thereby creating healthier workplaces.

HVAC surfaces were reduced by an overall average of 99%. With UVGI on, workers reported 30% fewer work-related mucosal symptoms, 40% fewer respiratory symptoms, and 20% fewer symptoms overall than with UVGI off.

The authors believe UVGI lamps could be installed in most existing office buildings and, based on the incidence of building-related illnesses among U.S. workers, could resolve work-related symptoms due to HVAC microbial contamination in about 4 million people in the United States alone. They estimate the cost of installing these systems at approximately \$52 per worker, with annual maintenance costs of approximately \$14 per worker. A report in the September 2002 *American Journal of Public Health* estimates productivity losses among U.S. workers due to building-related illnesses at \$20–70 billion annually, or \$225–787 per worker.

While agreeing that UVGI can be effective in killing microbes, critics question the relevance of the study's conclusions for widespread application.

Karin Foarde, director of the Microbiology Department at Research Triangle Institute in Research Triangle Park, North Carolina, who has extensively studied the effectiveness of UVGI, notes, "The buildings had such low levels of contamination to begin with, I have concerns about the strength of the authors' conclusions on surface and airborne reductions." She adds, "It would be interesting to know how UVGI would perform in a humid climate like the Southeast with higher levels of contamination." —**John Manuel**

## ehpnet

Environment, Health,  
and Safety Online

Professionals in chemistry, engineering, and environmental science are working to deliver factual and easy-to-understand information at the grassroots website Environment, Health, and Safety Online (<http://www.ehso.com/>). This densely packed website of more than 2,000 pages describes itself as offering “free, objective information for the general public and environmental health science professionals.”

From its initial screen, readers can access the latest science news from the *Federal Register* and federal agencies including the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Department of Transportation (DOT). Under the State Agencies link at the top of the page, there are also links to various sites sponsored by each state's environment-related agencies.

Under Free Information for the General Public and EHS Professionals, more than 200 topics are listed alphabetically, ranging from aflatoxin to workplace health issues. These pages pull together resources from across the Internet. For instance, a visitor can click on Employee's Rights Under OSHA to learn what training an employer must supply about working with chemicals, how to ask an employer to correct violations, how to file complaints with OSHA—even how to download the official OSHA complaint form. The PPE—Personal Protective Equipment section gives information about who must wear respirators, the various types of respirators, and how to select, fit, clean, disinfect, and routinely inspect a respirator.

To the left of this table of contents, visitors can select Search Government Sites to find federal communications of interest—for example, to review the current wording of a federal or state regulation, find a regulation on a certain topic, or search for *Federal Register* notices that affect a particular business. Links at this page find answers to such questions by searching the Code of Federal Regulations, *Federal Register* notices, and federal agency websites. Inquiries can be narrowed to search only the most recent EPA, OSHA, or DOT regulations.

To decipher technical jargon, visitors can click on Acronyms at the top of the homepage to check the alphabetized list of about 125 terms commonly used by environmental health professionals. The list helps novices understand unfamiliar terms, and also serves as a quick memory jogger for professionals searching for the meaning of uncommon terms.

A section called Pollutor News describes the enforcement of EPA regulations against environmental criminals. Pollutor News reports on the enforcement of regulations against environmental criminals, such as the EPA's recent fining of a Tucson company for storing hazardous chlorine without reporting it to state and local authorities. The company chlorinates swimming pools and was storing 10 times more chlorine than the minimum for which reporting is required.

The website was created in 1998 by chemical engineer John Slemmer, who maintains the site as a free public service. Slemmer welcomes inquiries from other professionals who want to help maintain and improve the website. —Carol Potera

Death Toll of Biomass  
Burning

Indoor burning of biomass such as wood, dung, crop residue, and charcoal kills 1.6 million people each year, including 1 million children, reports the nongovernmental British Intermediate Technology Development Group. Biomass releases particulate matter when burned, which can contribute to diseases such as pneumonia, cancer, tuberculosis, and asthma.

The group's December 2003 report, *Smoke: The Killer in the Kitchen*, says 2.4 billion people burn biomass for cooking and heating, and another 200 million people will do so by 2030. Over half the people using biomass live in China and India, although the proportion of biomass use is highest in sub-Saharan Africa.

Environmental  
Polymorphism Registry  
Launched

January 2004 saw the launch by the NIEHS and the University of North Carolina—Chapel Hill of the Environmental Polymorphism Registry. This innovative registry will eventually contain genetic data gathered from blood samples collected from more than 20,000 consenting subjects. It will allow researchers at the two facilities to identify groups with genetic polymorphisms and therefore better study the complex nature of the links between environmental exposures, genetic susceptibilities, and human disease.

AAP: Soft Drinks and  
Schools Don't Mix

An American Academy of Pediatrics policy statement in the January 2004 issue of *Pediatrics* calls on schools to stop selling soft drinks and start providing healthier alternatives such as real fruit juice and water. Easy access to sugary foods and drinks is part of the obesity problem in the United States, where 15% of children aged 6–19 are overweight. Sugared soft drinks also contribute to dental cavities and enamel erosion.



The statement advises doctors to educate not only their patients but also school administrators about how sugared soft drinks can impact health. It also notes that the rise in children's soft drink consumption is leading to less milk consumption, which could jeopardize the formation of maximal peak bone mass at a critical time for such development.